

The appearance of the spark-discharge changed with the pressure in the usual manner. At ordinary pressures the discharge was a bright white spark, gradually passing, as the pressure was lowered, into a purplish glow. In the case of the flat and convex discs of Part I, the purple discharge, at first central and narrow, gradually spread out and at low pressures filled the space between the plates. The appearance of the spark could not, however, be carefully examined, as the circuit was always broken as soon as discharge occurred in order to avoid damage to the surfaces of the plates. When these were examined by breathing on them after a number of sparks had passed at low pressures, it was always found that the part of the surfaces most affected by the discharge was an annulus at some little distance from the centre. With the flat plates used in Part II, the discharge was generally diffused over the space between the plates.

Observations of spark discharge between plates in air at different pressures have been made by Warren de la Rue and H. Müller\* and by Macfarlane.† Their results do not present the features to which attention has been called in the present paper, nor could they do so, as the curves for potential difference and pressure for the spark-lengths they examined would show no evidence of a minimum potential difference at the lowest pressures they considered. In both cases the spark-length was about 0.13 inch, and the lowest pressure 20 mm. of mercury.

In conclusion, I have to express my thanks to Professor J. J. Thomson, to whom I have been indebted for advice and suggestions at every point of this investigation.

## VII. "Electro-chemical Effects on Magnetising Iron. Part IV."

By THOMAS ANDREWS, F.R.S., M.Inst.C.E. Received May 16, 1892.

### *Influence of Magnetisation on Corrosion of Steel.*

In connexion with, and during the progress of, the electrical portion of my research on "Electro-chemical Effects on Magnetising Iron," Parts I, II, and III ('Roy. Soc. Proc.,' vols. 42, 44, and 46), numerous gravimetric experiments were conducted, with the object of investigating the influence of magnetisation on the corrosion of iron and steel. I selected as the corrosive fluid a solution of cupric chloride, being partly guided in this choice by the results obtained with solutions of this salt in the electrical portion of the investigation.

\* 'Phil. Trans.,' vol. 171, pp. 75—82, 1880.

† 'Trans. Roy. Soc. Edinb.,' vol. 28, p. 642, 1878.

The action of this salt on iron and steel is also very powerful, and ensures freedom from the disturbing influences of violent effervescence. Moreover, the results obtained with a copper solution of this nature afforded an opportunity of simultaneously obtaining an indication of the influence of magnetisation on the electrolytic deposition of copper from its solutions on iron and steel. The investigation was conducted as follows: the steel bars employed were of the lengths and diameters given in Table I, each pair being cut adjacently from a long finely-polished rod, so that the bars were as near as practicable alike in general composition and structure. For every set of experiments one of the steel bars was magnetised, the other being retained in its unmagnetised state. The bars were each weighed on the balance, and afterwards each bar was immersed in an equal quantity of cupric chloride solution, in separate beakers, a considerable distance apart (see fig. 1); the two beakers were of the same diameter and fluid capacity; the bars were placed in the beakers in the position shown in fig. 1. On the completion of the periods of immersion stated in

FIG. 1.

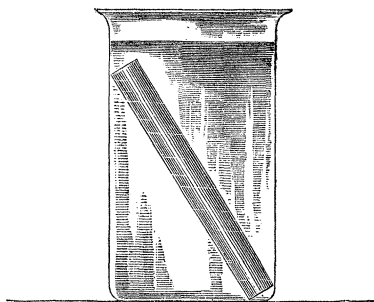


Table I, each bar was taken out, and on removal from the solution the electro-deposited copper was mostly found surrounding the steel bar in the form of a compact hollow pipe or cylinder; this was easily drawn off from the remains of the steel bar, which formed a kind of core within. The rods were carefully washed and cleansed from any loosely adherent copper and carbonaceous deposit, dried, and then weighed. A new pair of finely polished steel bars, one magnetised, the other unmagnetised, was prepared in the above-named manner for every experiment. The results obtained are stated in Table I.

The cupric chloride solution was prepared as follows: 4 ounces of crystallised cupric chloride were dissolved in 20 fluid ounces of water, and each steel bar was immersed as previously described in an equal quantity of this solution. A fresh solution of  $\text{CuCl}$  was prepared for every set of observations, and the methods resorted to, with manipu-

Table I.—Influence of Magnetisation on the Corrosion of Steel.

Size of bars.		Time of exposure in cupric chloride solution.		Quantity of cupric chloride solution.	Loss in weight of unmagnetised steel bar.		Loss in weight of magnetised steel bar.		Increased loss in weight of the magnetised steel bar.
Length.	Diameter.	h.	m.		grains.		grains.		
in.	in.								per cent.
4½	0.296	19	30	10 fluid ozs.	247.00		260.00		5.27
3	0.296	24	0	10 "	153.00		167.40		9.41
3	0.296	24	0	10 "	179.30		191.30		6.69
3	0.296	24	0	10 "	241.80		247.90		2.73
3	0.296	24	0	10 "	247.60		253.60		2.42
3	0.260	12	0	10 "	96.70		98.94		2.32
3	0.296	12	0	10 "	112.91		122.85		8.80
3	0.296	24	0	4000 fluid grs.	196.08		212.60		8.43
3	0.296	24	0	4000 "	179.80		187.34		4.19
3	0.296	24	0	4000 "	206.38		206.85		0.23
3	0.296	24	0	4000 "	189.03		190.54		0.80
4	0.250	24	0	10 fluid ozs.	233.43		237.39		1.70
4	0.250	24	0	10 "	221.26		227.46		2.80
4	0.250	24	0	10 "	219.53		222.14		1.19
4	0.250	24	0	10 "	239.40		230.22		0.36
4	0.260	24	0	10 "	224.13		228.72		2.05
4½	0.301	24	0	10 "	236.74		237.19		0.19
4½	0.301	15	35	10 "	215.32		219.59		1.98
4	0.260	18	30	10 "	210.54		215.30		2.26
4½	0.301	15	0	10 "	203.64		208.06		2.17
4	0.260	14	15	10 "	187.37		187.99		0.33
4½	0.301	6	0	4300 fluid grs.	165.04		173.10		4.88
4½	0.301	6	30	4200 "	164.17		171.99		4.76
4½	0.301	6	3	4200 "	164.92		169.59		2.83
4½	0.301	6	0	4200 "	151.13		152.24		0.73
4½	0.301	6	0	4200 "	211.50		221.37		4.67
4½	0.301	13	45	4200 "	259.53		262.21		1.03
4	0.260	13	0	4200 "	216.62		217.08		0.21
Average.....									3.05

The temperature of the laboratory averaged about 55° F. during the experiments. At the end of each experiment the copper solution was tested with a bit of bright iron to ascertain that it was not exhausted, and in every case copper was instantly deposited.

lative care, ensured exactitude for purposes of comparison between the behaviour of the magnetised and unmagnetised steel bars in the corrosive fluid.

An average of the twenty-nine experiments in Table I indicates an increase of corrosion in the steel due to magnetic influence of about 3 per cent. under the conditions of experimentation.

The steel bars were not highly magnetised, and I purposely exposed them to the action of the solution for somewhat long periods in the present experiments, as thereby, perhaps, affording a better indication of the influence of magnetisation on general corrosion, the almost immediate effect of magnetisation on the corrosion of steel having been demonstrated in the electrical observations of Part II.

It is probable that the deviation in the individual results of Table I, in the extent of the loss by corrosion, may be attributed to variation in the extent to which the several bars were magnetised. The results recorded in the present paper indicate that magnetisation exerts an effect, though small, on the extent of the corrosive action of copper salts on iron and steel. This is probably owing to the local currents, set up by magnetisation between the polar and central portions of the bars, inducing somewhat greater chemical action.

In some of the experiments with the copper solution which contained the more highly magnetised bars, the copper solution was of a perceptibly lighter colour towards the end of an experiment when compared with the colour of the copper solution containing the unmagnetised steel bar.

VIII. "Note on the Spectra of the Flames of some Metallic Compounds." By G. D. LIVEING, M.A., F.R.S., Professor of Chemistry, and J. DEWAR, LL.D., F.R.S., Jacksonian Professor, University of Cambridge. Received June 3, 1892.

[PLATE 5.]

A study of the spectra of flames offers many points of interest. It is long since A. Mitscherlich (Poggendorff's 'Annalen,' vol. 116, p. 499; vol. 121, p. 459) showed that the spectra of flames are, for the most part, those of compounds of the elements present, and contain comparatively few rays proceeding directly from the elements themselves. But there are many questions still undecided. For example, it is not known whether the vibrations which give the spectra of compounds in flames are those which the molecules of the compounds in question would assume under the action of a high temperature alone, or whether they are not vibrations of a different order, arising during

FIG. 1.

